COSTS OF STORING AND HANDLING GRAIN IN OKLAHOMA COOPERATIVE ELEVATORS

By

JEFF R. MARSHALL

Bachelor of Science

University of Nevada, Reno

Reno, Nevada

1979

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
July, 1983

COSTS OF STORING AND HANDLING GRAIN IN

OKLAHOMA COOPERATIVE ELEVATORS

Thesis Approved:

Robert K. Oehsman
Thesis Adviser

R. E. Page

James R. Russell

Norman N. Durham
Dean of Graduate College

PREFACE

This study presents an analysis of the costs of storing and handling grain in Oklahoma cooperative elevators. The primary objective is to develop a procedure for determining consistent estimates of the costs of storing and handling grain for individual elevators and an average across all elevators. Individual elevators can compare their costs to the average to determine the relative strengths and weaknesses in their cost structure.

I would like to express special appreciation to my graduate committee, Dr. Robert L. Oehrtman, Dr. James R. Russell, and R. E. 'Gus' Page for the guidance and assistance in the planning stages of this project and for their suggestions on improving the final manuscript. I am grateful to the Department of Agricultural Economics for providing financial assistance and for providing the opportunity to continue my education. The faculty of the Department of Agricultural Economics also deserves much appreciation for their 'open door' policy and for their time and devotion in helping students achieve their goals.

Many thanks are due to Betty Harris for her typing skills and her ability to weather the many changes made to this manuscript. A final note of thanks goes to my fellow graduate students whose support and friendship have made the graduate program an enjoyable experience that will provide many fond memories in the future.

TABLE OF CONTENTS

Chapter		Page
I.	THE RESEARCH PROBLEM	1
	Introduction	1
	Statement of Research Problem	3
	Purpose and Objectives of the Study	5
	Organization of the Study	7
II.	LITERATURE REVIEW	9
	Introduction	9
	Analyses of New Grain Elevators	9
	Analyses of Existing Grain Elevators	10
	The Impacts of Dust Control	14
	Allocation of Labor Expenses	14
III.	PROCEDURES	18
	Source of Data	18
	Sampling Procedures	20
	Stratification	20
	Sample Size	20
	Allocations of Expenses	24
	Fixed Expenses	25
	Variable Expenses	26
IV.	RESULTS	28
	Calculations	28
	Results	29
	Statistical Analysis	40
V.	SUMMARY AND CONCLUSIONS	50
	Areas for Future Research	54
SELECTED BIBLIOGRAPHY		56
APPENDIXES		59
	APPENDIX A - SURVEY QUESTIONNAIRE	59
	APPENDIX B - VISICALC TEMPLATES	67

LIST OF TABLES

Table		Page
1.	Production of Wheat and Total Grains, and the Percentage of Agricultural Receipts From Wheat and Total Crops in Oklahoma, 1960-1981	2
II.	Sample Sizes, Variances, and Strata Sizes by Elevator Capacity	23
III.	Weighted Average Annual Cost per Bushel for Elevators Between 200,000 and 399,999 Bushels Storage Capacity	30
IV.	Weighted Average Annual Cost per Bushel for Elevators Between 400,000 and 699,999 Bushels Storage Capacity	31
V.	Weighted Average Annual Cost per Bushel for Elevators Between 700,000 and 999,999 Bushels Storage Capacity	32
VI.	Weighted Average Annual Cost per Bushel for Elevators Between 1,000,000 and 1,999,999 Bushels Storage Capacity	33
VII.	Weighted Average Annual Cost per Bushel for Elevators With 2,000,000 Bushels or More Storage Capacity.	34
VIII.	Weighted Average Annual Cost per Bushel for All Storage Capacities	35
IX.	Effects of Interest and Transportation on the Average Total Cost of Handling Grain	38
X.	Effects of Interest and Transportation on the Average Total Cost of Handling Grain	39
XI.	Effects of Interest on Average Total Costs of Storing Grain.	41
XII.	Analysis of Variance and Confidence Limits on Handling Costs.	43
XIII.	Analysis of Variance and Confidence Limits on Storage Costs.	44

Table Page

XIV. Analysis of Variance Table for Testing the Equality of Handling Costs Between Elevators Grouped According to Storage Capacity 46

XV. Analysis of Variance Table for Testing the Equality of Storage Costs Between Elevators Grouped According to Storage Capacity. 46

XVI. Analysis of Variance Table for Testing the Equality of Handling Costs Between Elevators Grouped According to Handling Volumes. 47

XVII. Analysis of Variance Table for Testing the Equality of Storage Costs Between Elevators Grouped According to Handling Volumes. 47

XVIII. Analysis of Variance Table for Testing the Equality of Handling Costs Between Elevators Grouped According to Storage Volumes 49

XIX. Analysis of Variance Table for Testing the Equality of Storage Costs Between Elevators Grouped According to Storage Volumes 49

CHAPTER I

THE RESEARCH PROBLEM

Introduction

In today's highly competitive grain marketing environment, a few pennies can mean the difference between profit and loss. Cooperative grain elevators are no different than any other type of business and must operate as efficiently and economically as possible. In addition to storing and handling grain, cooperatives have expanded their services to include such departments as feed, fertilizer, gas, oil, and other farm supplies. Cooperatives that have diversified require better management to ensure the efficient operation of all departments.

Oklahoma is one of the three largest producers of winter wheat; therefore, feed grain production is an important component of the agricultural economy of the state. Table I shows the production of wheat and total grains, and the percentage of agricultural receipts from wheat and all crops combined for Oklahoma since 1960.

The costs of operating grain elevators are related to the volume of grain stored and handled. Fluctuation in grain production (shown in Table I) may lead to variations in annual elevator costs. These fluctuations in production may result from variations in weather, competition, or government programs. Grain elevators must be able to adapt to the constantly changing conditions that arise from government

TABLE I

PRODUCTION OF WHEAT AND TOTAL GRAINS, AND THE PERCENTAGE OF AGRICULTURAL RECEIPTS FROM WHEAT AND TOTAL CROPS IN OKLAHOMA, 1960-1981

YEAR	WHEAT PRODUCTION (1,000 Bu.)	TOTAL GRAIN PRODUCTION (1,000 Bu.)	PERCENT OF AGRICULTURAL RECEIPTS FROM: WHEAT	ALL CROPS
1960	121,290	183,330	27.5	49.2
1961	111,960	168.667	27.5	46.8
1962	71,079	112,567	21.0	40.1
1963	75,411	114,495	26.7	40.8
1964	96,623	133,444	20.0	40.1
1965	132,916	173,280	22.0	40.9
1966	98,700	137,584	18.2	33.0
1967	88,689	126,380	17.0	33.0
1968	124,200	169,969	12.2	27.1
1969	121,800	172,235	14.0	28.8
1970	101,400	154,805	16.4	29.3
1971	72,000	128,032	11.8	24.1
1972	89,700	136,189	10.8	22.7
1973	157,800	210,995	22.0	32.3
1974	134,400	173,692	28.7	42.6
1975	160,800	198,684	28.8	42.4
1976	151,200	191,951	20.6	34.3
1977	175,500	222,990	23.1	37.8
1978	145,800	178,725	16.3	29.6
1979	216,600	263,395	25.10	36.9
1980	195,000	225,120	23.40	33.5
1981	172,800	210,510	N.A.[1]	35.8

[1] Not Available

Source: Oklahoma Agriculture Statistics, Oklahoma Department of Agriculture. Various issues.

programs and technological developments in production and marketing. The recent government farm program (PIK) will have a significant effect on the volume of grain handled by country elevators.

Statement of Research Problem

Elevator managers have the problem of adjusting expenses and elevator operations in order to minimize operating costs and yet be flexible enough to adapt to yearly fluctuations in storing and handling volumes. Higher than average yields, slow market activity, and government programs have resulted in stored grain being carried over from season to season. Large reductions in grain production may result in an over abundance of available storage space in country elevators. The cost of supplying sufficient storage capacity for grain and ways to reduce these costs are important to grain elevators, farmers, consumers, and the U.S. government.

The price of wheat in Oklahoma is strongly influenced by the price of wheat in the Gulf export market. Elevators that purchase grain take the Gulf price and deduct a margin to determine the cash price that they will pay for farmer's grain. The margin includes handling, storage, and transportation costs and an allowance for risk and profit for the elevator. An elevator should attempt to maintain a margin that is sufficient to cover the costs of storing and handling, as well as a normal rate of return on investment.

With increasing competition between elevators and from on-farm storage, elevators may unknowingly narrow their margins to the breakeven point or beyond in an attempt to maintain a constant flow of grain through their facility. Elevators often waive storage and

handling charges for short periods if farmers agree to market their grain through the elevator. If costs are not known, the elevator may narrow the margin to the point that a loss may be unknowingly incurred.

Transportation costs can be verified or arranged prior to shipment. Transportation costs are not under the control of the elevator and the elevator must accept the going rates. Storage and handling costs are under direct control of the elevator. The elevator can charge a fee for these services to recover the cost of providing them. Elevators are subject to the provisions of the Uniform Grain Storage Act when charging customers for storing grain, but do not have a standard procedure to determine storing and handling costs. Elevators frequently have difficulty separating the costs for the elevator department from the costs of other departments.

Risk to the elevator is composed of four basic elements:

1. Insect damage and other dockage for quality;
2. Excess shrinkage;
3. Adverse price fluctuations; and
4. Adverse volume fluctuations.

The elevator has some control over the first two elements but not over the last two. Good management practices can help minimize the impacts of price and volume fluctuations.

The major problem confronting elevator managers is to accurately incorporate margin changes as they adjust the basis between the local cash price and the Gulf bid. The major variables in the margin that are under control of the elevator managers are the storing and handling costs. Elevator managers are lacking a uniform means of

arriving at consistent estimates of their storing and handling costs. Elevator managers need a procedure that can be used to compare storing and handling costs to an industry average and to their own costs on an annual basis. With these procedures an elevator manager can take the appropriate measures to maintain profitability in the elevator department.

Purpose and Objectives of the Study

Income to grain elevators from handling grain is derived primarily from the margin. Handling charges are usually charged when grain is stored and then removed for marketing through another source. Storage charges are calculated on a daily basis and revenue depends on the number of bushels currently stored in the elevator. The opportunity to earn income from storing and handling grain is dependent on the size of the crop. The elevator has limited control over the volume of grain that will be stored or handled for producers. An elevator may employ a pricing strategy to attract customers, but competition among grain elevators would be expected to force the charges for storing and handling grain to be consistent within regions.

Local prices of grain in various regional locations are not consistent with other prices offered by elevators within that region. This would indicate that there is a difference in the components that make up the margin. Transportation costs and risk should be relatively equal within regions, leaving storing and handling costs as the only factors that should differ. Variations in storing and handling costs may be due to differing volumes of grain. Operations

at cost would be feasible if costs and volumes could be accurately determined; however, if the volume were less than anticipated, the elevator may operate at a loss. To prevent this from occurring and to help offset the fluctuations in volume, elevators should follow a policy of competitive pricing that will yield earnings in excess of total costs. Pricing strategies employed by various elevators, aimed at increasing or decreasing the volume stored or handled, may be the reason for the variation in margins.

The major objectives of this study are as follows:

1. To determine the costs per bushel for storing and handling grain in Oklahoma cooperative elevators of various storage capacities and with different handling volumes;
2. To determine whether there is a significant difference in storage and handling costs for elevators with different storage capacities and different handling volumes;
3. To report the findings and procedures used to obtain the results in a form that elevator managers can use in management decisions; and
4. To develop a procedure for compiling and reporting an average weighted cost per bushel for storing and handling grain in Oklahoma so that elevator managers will have a figure for comparing their individual situations with an industry average.

When computed over a number of years, the cost figures can be used to identify changing conditions or trends with reference to the

performance of the elevator. Knowledge of the significant costs associated with storing and handling grain can be useful in pointing out the strengths and weaknesses of the elevator.

Comparing the costs of an individual elevator over time may indicate how the elevator is progressing, but this does not show how the elevator stands in relation to the rest of the grain industry. A method to compute an industry figure can help country elevators by providing cost figures that can be used for comparison so that an individual elevator can determine if its costs are higher or lower than the industry average.

Organization of the Study

Chapter II contains the literature review and highlights of previous research relating to grain elevator costs. The chapter contains four important sections. Each section discusses a particular aspect of previous studies that have been conducted. The sections discuss new elevator facilities, existing elevator facilities, the implications of dust control, and the allocations of labor expenses. The implications of dust control are discussed because of the possible effects on grain elevator operations in the future. The allocations of labor expenses are also discussed due to the varied nature of allocations and the relative importance of labor costs.

Chapter III describes the procedures followed in this study. The source of data, sampling procedures used to obtain the data, and the details of the procedures used to allocate costs to the storing and handling functions are described.

Chapter IV presents the results of the research and discusses the

cost figures associated with storing and handling grain. The costs are presented according to rated storage capacities.

Chapter V contains the summary and conclusions. Implications of this research project are discussed and recommendations for further research are presented.

The Appendix contains the survey questionnaire used in the mail survey of cooperative elevators. The VisiCalc templates that were used to calculate the results are also presented in the Appendix.

CHAPTER II

LITERATURE REVIEW

Introduction

Previous studies of the costs of storing and handling grain have analyzed both new and existing elevator facilities. Analyses of new elevators have primarily followed the engineering approach with the purpose of determining the feasibility of constructing and operating new elevator facilities.[1] Analyses of existing elevators have utilized case studies to collect cost data and determine relationships between resources and expense allocations. These case studies often have limited scope in that they only analyze a few "typical" elevators and must generalize the results to many different elevators. Schienbein conducted comprehensive surveys of port, inland, and country elevators to determine the per bushel costs of storing and handling grain. A study of this type averages out the many differences among elevators and reflects the average cost an elevator can expect to incur.

Analyses of New Grain Elevators

In 1957, Thurston and Mutti studied the cost-volume relationships for new country elevators. They developed elevator models from data collected from case studies of cooperative elevators in Illinois and from various contracting engineers. Thurston and Mutti held the

sideline business volumes constant for all their models. This enabled the sideline expenses to make up a variable proportion of total expenses at the various volume levels studied. A comparison between elevator models on the storage and merchandising functions could be made by keeping the sideline expenses fixed.

Schienbein analyzed the costs of storing and handling grain in newly constructed facilities. He used cost data based on the estimated cost of replacing the elevator's physical assets at the projected years price level. Schienbein found that the costs were 45 percent to 50 percent higher when using replacement costs than when using a standardized book cost approach (1974, p. 31). This was caused by a larger proportion of the total replacement costs coming from capital asset expenses.

Analyses of Existing Grain Elevators

The data for Schienbein's regional studies of port, inland, and country elevators were obtained through random sampling. Records from each sampled elevator were analyzed by auditors or accountants, and elevator managers were requested to respond to a written questionnaire. The depreciation and interest expense data from each elevator were recomputed using a standardized rate. Weighted average costs per bushel for storing and handling grain were then determined for the three categories of elevators. Schienbein's studies emphasized the fixed costs and variable costs associated with storing, receiving, and loading out grain by truck, rail and water. The studies analyzed the differences in costs according to the volume of grain handled among geographical areas as well as among types of

facilities (i.e. port, inland, country) within the geographical areas.

Schienbein also projected the costs of handling and storing grain. He estimated changes in volumes and costs to project the following years costs. Using the weighted average cost per bushel, Schienbein reported the costs of storing and handling grain for six geographical regions and a combined average for the United States.

Oehrtman used linear regression techniques on data published by Schienbein to predict the handling and storing costs for the fiscal years omitted in Schienbein's series of studies as well as for the years that were forecasted by Schienbein. This provided a consecutive set of estimates of the costs of storing and handling grain.

Establishing a per unit cost figure can be misleading because the costs of operating grain elevators are related to the volume of grain operations. Brown studied the ability of firms to adjust their costs to changing volumes and estimated the labor and total costs per bushel of handling grain at selected grain elevators associated with different levels of volume and varying sizes of elevators. He found that the higher the volume handled, the lower the costs per bushel and the lower the volume handled, the higher the costs per bushel. Thus, one of the major difficulties confronting elevator managers today is keeping expenses in line with fluctuating volumes.

Elevators that have diversified into other services (fertilizer, petroleum, farm supplies) may be able to utilize the idle time of facilities, equipment, and personnel to achieve more efficiency and thus lower the per unit costs of grain handling.

Yager conducted a study of cost-volume relationships in country

elevators in the spring wheat belt. Cost information was obtained from cooperative country elevators on a case study basis of the most commonly found elevator types and sizes. From these case studies, six elevator models of various types and capacities were constructed. Yager, as well as Schienbein, found that personnel expenses were the major variable expense as well as the most difficult to allocate to the storage and handling function. Yager found that variable costs per bushel were higher than fixed costs per bushel and that the size of the elevator and percent capacity utilization affected operating costs. The greater turnover, in relation to the capacity used for merchandising, decreased the cost per bushel.

Corley and Briscoe examined short run grain handling costs for single unit country elevators in Northwest Oklahoma. They constructed ten elevator models ranging in capacities from 100,000 to 900,000 bushels by 100,000 bushels, and an elevator with a 1,700,000 bushel capacity. Budgets for each elevator were constructed for the cost of handling grain. Data for these budgets were obtained through elevator audits, personal interviews with elevator managers, and from agricultural engineers and construction contractors. Elevator managers were selected on the basis of the years of service and degree of cooperation with the interviewer. Sideline enterprises and the storage function were not considered and only those expenses incurred by the handling of grain were compiled. Corley and Briscoe found that smaller firms required volumes in excess of 1.4 times their storage capacities in order to break-even and that larger firms could withstand greater decreases in handling volumes before breakeven

occurred (p.iii). They also found that salary expenses ranged from 34 percent to 55 percent of the total costs among the varying models (p. iii).

The effects of cost fixity and diversification on grain elevators were studied by Corley, Briscoe and Baker. Cost information was obtained from the detailed analyses of eight elevators and audits from five additional elevators. Interviews with elevator managers and other personnel were used to determine resource use and how cost items would vary with changes in volume and over time. They found that firms deriving the higher percentage of total revenues from non-grain sources had the lowest fixed to variable cost ratios. These elevators could shift resources to non-grain activities during periods of low grain handling volumes. Several management strategies were developed to adjust to low or widely fluctuating volumes.

Sloan analyzed the effects of declining volumes on elevator costs (total and per unit costs) for existing elevators. Sloan conducted a case study of a cooperative elevator. He found that the handling volume could decrease to roughly 39 percent of normal volume before showing a loss (p. 74). Further analyses showed that the elevator department contributed significantly to the success of the sideline operations. Since the elevator department was "carrying " the other enterprises, Sloan determined that handling volumes could not decrease below 56 percent of the normal volume before the association would show a loss (p. 75). Since the cost structure of this cooperative elevator was composed largely of fixed costs, the continued operation of the elevator depended upon moderately high levels of volume.

The Impacts of Dust Control

Increasing public awareness and government regulations have required many elevators to control the dust from grain handling operations. The number of elevators installing dust control systems continues to increase as more and more elevators are brought into compliance with the Clean Air Act.

Schnake reported that the estimated cost in 1976 to equip a country elevator to meet Clean Air Act standards was over $225,000,and that the cost to equip the same elevator in 1980 was about $500,000 (p. 14). For an elevator handling 1,000,000 bushels annually, a $500,000 investment would amount to approximately a 6.25 cents per bushel increase in handling costs over the life of the equipment. If a dust removal rate of .0015 is considered, dust removal amounts to an additional .6 cent per bushel shrink on $4 per bushel grain. Schnake indicates that relative to "typical" 1978/1979 elevator in and out charges of 10 cents per bushel, the additional 6.85 cents per bushel cost for dust removal would increase in and out charges by 68%.

Allocation of Labor Expenses

Labor expense is the largest single expense associated with handling grain. Labor is also the most difficult expense item to break down into a storing or handling component. This is due to the transitory nature of labor in grain elevators. One employee may be responsible for several tasks that are unrelated to the storing or handling of grain, and no records are kept of the time each employee spends in each "department." These factors make the allocation of

labor expenses to specific functions very difficult. Procedures for determining labor expenses have varied depending on the type and purpose of the study.

A time and motion study may be the most accurate method of pinpointing labor activity in a working environment. In order to reduce the cost of a time and motion study, Brown and Sloan utilized the work-sampling technique.[2] Brown expressed his estimates of labor employment in terms of man-day equivalents by multiplying the percentage of labor time allocated to each category by the total number of men employed. He analyzed 8 elevators and found that labor costs as a percentage of total costs ranged from 38 percent to 60 percent. Brown also analyzed labor costs at all-grain elevators and concluded salaries and wages remained stable from year to year even though the volumes of grain handled fluctuated widely. Since labor costs were relatively fixed, a low volume resulted in a high per bushel cost as the fixed outlay was spread over a small number of bushels. Thus a high volume leads to a lower per unit cost of labor.

Thurston and Mutti developed personnel expenses from case study elevators and audit information from Illinois country elevators. Differences in employee annual wages between models were directly related to the maximum storage capacity of the model. Such differences reflect increased employee responsibilities in both the storing and handling functions. Thurston and Mutti charged labor expenses to the storage functions on the basis of the estimated direct labor used. They then determined grain merchandising and handling costs of labor as a residual by deducting the allocation for the sideline and storage functions from the total labor costs.

Corley and Briscoe took observations of total salary expenses and number of bushels handled by each of their ten elevator models. A linear regression was fitted to the data (total salary expense on volume handled) to determine total salary expenses for other sizes of elevators.

Yager allocated labor expenses to the storage function on the basis of volume stored to volume handled. The remaining portion of their salaries and other labor expenses were allocated to the merchandising function. Yager assumed efficient employees and varied the number of employees required among different elevator models. Schienbein interviewed elevator managers to obtain estimates of the number of men utilized in the storing and handling functions. He multiplied the hours of operation for the storing and handling functions times the number of men utilized in each function to obtain the man-hours for each function. Schienbein then allocated direct labor expenses from the ratio of man hours for each function to the total man hours available for all functions. The administrative overhead was allocated on the basis of elevator managers estimates and the volume ratios for each function.

ENDNOTES

[1]The engineering approach constructs an elevator model and determines the amount and value of resources required to operate the facility. This approach implies an ideal or very efficient level of operation unless inefficiencies such as idle labor time, breakdown delays, etc. are incorporated into the model.

[2]Work-sampling consists of random observations of employee's activities during a period of time and then determining the percentage of total employee's time that was spent in each activity.

CHAPTER III

PROCEDURES

Source of Data

Sources of data in previous studies have varied, depending on the type of study. The economic-engineering studies have used case studies of elevators as a 'foundation' to construct elevator models typical to the region of the study. This approach is useful when examining the costs of building, staffing, and operating an elevator under predetermined conditions. There are many differences between grain elevators, such as their location, size of facility, and type of 'sideline' enterprises. For many elevators, the term sideline can be misleading because the income from these 'sideline' enterprises may exceed that from the elevator department. Economic-engineering studies may provide a biased estimate of costs of storing and handling grain and the validity of the estimates cannot be tested with conventional statistical analyses.

The best way to obtain an unbiased estimate of the true costs of storing and handling grain is to obtain a random sample of costs from the population of grain elevators. These samples can be tested with basic statistical concepts and within the framework of standard statistical analyses.

The 95 cooperative elevators listed in the 1982 directory of

Farmers Cooperative Grain Dealers of Oklahoma served as the population from which the survey sample was drawn. Cooperative elevators were chosen because their operations and accounting data were thought to be more homogeneous.

A mail survey questionnaire was developed to obtain the relevant expense and organizational data. The survey instrument is presented in Appendix A. The mail survey approach was chosen over personal interviews because of the high expense of conducting personal interviews. The relevant expense data can be obtained from the comparative expense statement in the annual audit report, but data reflecting the organization of the elevator (i.e. allocation of labor, administrative overhead, etc. to the storing or handling functions) are not as readily available. A work-sampling or time and motion study could be used to determine amounts of labor and administrative expenses to allocate to the storing and handling functions of the elevator. This method would be very costly and time consuming to complete because of the diverse nature of each grain elevator. The survey questionnaire relies on each elevator manager's judgment to determine amounts of labor and administrative expenses that are used in the storing and handling functions.

The 1980 crop year was chosen as a base year in this study because the total volume of grain harvested in 1980 could be considered representative of future crop conditions, and yields. Since storing and handling costs depend highly on the number of bushels handled, production or yield of grain above or below the 1980 level will lower or raise the costs per bushel of handling grain.

Sampling Procedures

Stratification

The 95 cooperative grain elevators were divided into 6 strata according to their rated storage capacities. The stratification enabled testing of the hypothesis that storing and handling costs decrease as the size of elevators increase. Stratification also ensures that a sufficient number of different size elevators can be obtained to reach a valid conclusion.

The strata were sampled randomly in order to obtain unbiased estimates of the stratum means and variances. The estimates of the stratum means can be combined to give an unbiased estimate of the population mean. Dividing the population into strata should return a more accurate estimate of the population mean than from an unstratified sample of the same total number of units because the variation within each stratum should be less than the variation over the whole unstratified population.

Sample Size

The sample size that will yield the best and most accurate estimate depends on the variability in the population. In a stratified sample, the precision of the stratum means can be increased by taking a larger sample from the more variable strata. Sampford (p. 208) indicates that if the variances for the strata are known, or can be approximated, the sample size can be calculated from the formula:

$$n_i = h\, N_i\, S_i$$

where: n_i = the sample size from stratum i

h = constant for all strata, to be determined

N_i = the population of stratum i

S_i = the standard deviation of stratum i

The formula for the sampling variance is:

$$S_y^2 = \Sigma \left(\frac{N_i}{N}\right)^2 \frac{S_i^2}{n_i} (1 - f_i)$$

where: N = the total population

S_i^2 = the variance of stratum i

$f_i = \frac{n_i}{N_i}$ and is the sampling fraction for stratum i

By substituting n_i into the formula for the sampling variance, the formula reduces to:

$$S_y^2 = \Sigma \left(\frac{N_i S_i}{hN^2} (1 - hS_i)\right)$$

The sampling variance measures the amount of variation that can be expected about the mean of a sample. In order to obtain an estimate of the costs of handling grain (with a probability of 95 percent) that will be within .75 cents of the true cost, the estimated standard error of the total will have to be about .38 cents.

The estimated standard error of the total was calculated from the standard t test:

$$t = \frac{\bar{y}_n - E(\bar{Y}_N)}{s_y}$$

where: $\bar{y}_n$ = the random sample mean

$E(\bar{Y}_N)$ = the expected population mean

s_y = the estimated standard error

For $t = 1.96$ (95 percent level and ∞ degrees of freedom) and

$\bar{y}_n - E(\bar{Y}_N) = .75$ cents, s_y will equal .38265 and s_y^2 will equal .14642. Since a random sample is being conducted, the estimated variance of the population mean (s_y^2) can be substituted for the true sampling variance of the mean (S_y^2).

Now, if the within stratum variances (S_i^2) can be approximated, by some means, the formula for the sampling variance can be solved for h (Sampford, p. 209).

$$h = \frac{\Sigma N_i S_i}{N^2 S_y^2 + \Sigma N_i S_i^2}$$

Once h has been obtained, the sample sizes for each stratum can be determined from the formula $n_i = h N_i S_i$.

The within stratum variances (S_i^2) were approximated using the results from a study conducted by Corley and Briscoe in 1965. Although these variances are only approximations, they may be representative of the relationship between the stratum variances and are probably more accurate than approximations which do not incorporate this information.

Table II shows the 95 cooperative grain elevators separated into six strata according to rated capacity and shows the respective strata size (N_i), approximated within stratum variances (S_i^2) and within stratum standard errors (S_i) from Corley and Briscoe, and the calculated sample sizes (n_i) for each strata.

Since no information was available for stratum six, the survey questionnaire was pre-tested on five of the seven elevators in this stratum. Survey questionnaires were mailed to the remaining 46 elevators that were chosen at random within each stratum.

TABLE II

SAMPLE SIZES, VARIANCES, AND STRATA SIZES BY ELEVATOR CAPACITY

STRATUM	ELEVATOR CAPACITY (1000 Bushels)	N_i	S_i^2	S_i	n_i
1	< 200	15	19.01	4.36	8.6
2	200 to 399	14	25.70	5.07	9.3
3	400 to 699	24	15.68	3.96	12.5
4	700 to 999	17	15.44	3.93	8.7
5	1,000 to 1,999	18	10.37	3.22	7.6
6	> 2,000	7	NA[1]		5.0
		N = 95			n = 51.0

[1]Not Available.

Allocations of Expenses

Expenses can be separated into fixed and variable expenses. Fixed expenses remain the same in total as activity increases or decreases. Variable expenses are those that increase or decrease proportionately with increases or decreases in activity. In the long run all expenses are variable, but in the short run some expenses are fixed. Expenses that display both fixed and variable characteristics could be classified as semi-variable expenses. Examples of semi-variable expenses would be some administrative salaries, machine rentals or leases, and utilities. A minimum cost is incurred to have these services available, whether or not they are fully utilized. Beyond this minimum cost, which is fixed, any additional use will increase the cost, and will be a variable expense. The electricity hookups to many branch elevators are an excellent example of semi-variable expenses. This type of cost structure may cause a stepwise pattern in per unit costs to exist.

An examination of fixed and variable expenses indicates the difficulty of designating them as either fixed or variable. The time frame must also be considered when making this decision. For the purposes of this study, expenses are only separated into fixed and variable expenses. These expenses can be considered as actual 'out-of-pocket' expenses, i.e. expenses that are actually paid by the elevator. For the purposes of this study, depreciation is included as an 'out-of-pocket' expense even though it is a non-cash or book expense. By including an opportunity cost with the 'out-of-pocket' expenses, the 'economic' costs of storing and handling grain can be determined.

Fixed expenses include depreciation, insurance, taxes, leases and rentals, licenses and bonds, and interest paid. Variable expenses include direct labor, administrative overhead, electricity and utilities, chemicals, repairs, and other related expenses. The methods used to allocate fixed and variable expenses between storing and handling grain are outlined below.

Fixed Expenses

Depreciation. The total depreciation expense was broken down into three parts; elevator and equipment depreciation, office building depreciation, and all other depreciation. These can be determined from the detailed depreciation schedules. Elevator and equipment depreciation was then allocated between the storing and handling functions on the basis of the portion of the elevator utilized in each function. The depreciation for the office building was allocated to the elevator department and between the storing and handling functions in the same proportions as administrative overhead was allocated. All other depreciation was allocated to the elevator department on the basis of the proportion of other facilities used by the elevator department and storing and handling functions.

Insurance. The insurance expense was allocated to the elevator department and between the storing and handling functions in the same proportions as depreciation.

Insurance. The insurance expense was allocated to the elevator department and between the storing and handling functions in the same proportions as depreciation.

Taxes. The taxes were allocated to the elevator department and between the storing and handling functions in the same proportions as depreciation.

Leases and Rentals. The total amount of leases and rentals used in the elevator department and utilized in the storing and handling functions was determined from estimates of elevator managers.

Licenses and Bonds. The total license and bonds expense was allocated to the elevator department and to the storing function.

Interest Paid. The interest expense was allocated to the elevator department and the storing and handling functions in the same proportions as depreciation.

Variable Expenses

Administrative Overhead. Administrative overhead was allocated to the elevator department and to the storing and handling functions from estimates made by elevator managers.

Electricity and Utilities. Electricity and Utilities were allocated to the elevator department and to the storing and handling functions from estimates made by elevator managers.

Trucking Expenses. Trucking expenses incurred by the elevator were determined by elevator managers and were allocated to the handling function.

Chemicals. Chemicals and fumigants were allocated to the storage function.

Repairs. The cost of repairs to the elevator department was determined by elevator managers. The cost was allocated between the storing and handling functions on the basis of the hours of operation of each function.

Direct Labor. Direct labor was allocated to the elevator department, and to the storing and handling functions by multiplying the ratio of man-hours for each function to total man-hours of all functions times the labor expense.

Other Expenses. Other expenses applicable to the elevator department were allocated between the storing and handling functions on the basis of the volume of grain stored or handled in each function.

CHAPTER IV

RESULTS

Calculations

Data received from the survey questionnaires were compiled and the results were calculated following the procedures outlined in Chapter III. Computations were facilitated through the use of the VisiCalc electronic spreadsheet on the TRS-80 Model II micro-computer.

The survey data were placed in the "MASTER/VC" VisiCalc template that was constructed to calculate the costs for each elevator and allocate the costs to receiving grain by truck, loading out grain by truck and rail, and storage costs. Results from individual computations were stored in Data Interchange Format (DIF) files to serve as a data set for computing the weighted average costs. The individual storing and handling costs were weighted by the bushels of grain stored or handled by each elevator and the weighted average costs were computed for each stratum and for the average over all elevators.

The weighted average costs for each stratum and over the whole population were also calculated with the aid of the VisiCalc program. A template was constructed so that the DIF files containing results from individual elevators could be loaded into the template and average costs computed automatically.

Individual results from this study were returned to the

respective elevators along with the weighted average costs so that the elevator managers could make a comparison of their costs to the average of all elevators.

Results

The results for this study are presented in Tables III through VIII. These tables show the weighted average out-of-pocket costs for storing and handling grain as fixed and variable costs. In addition, handling costs are separated into the cost for receiving grain by truck and the cost of loading grain out by both truck and rail. Table III presents annual costs for elevators with storage capacities between 200,000 and 399,999 bushels. Table IV presents annual costs for elevators between 400,000 and 699,999 bushels storage capacity. Table V presents annual costs for elevators with storage capacities ranging from 700,000 to 999,999 bushels. Table VI presents annual costs for elevators with storage capacities ranging from 1,000,000 to 1,999,999 bushels and Table VII presents annual costs for elevators with capacities of 2,000,000 bushels or more. Cost figures are presented in cents per bushel and are the weighted average of the individual elevator costs within each group. Table VIII presents weighted average annual costs across all size intervals of elevators.

The total handling cost can be obtained from the tables by summing the receiving and loading out costs. These figures represent the costs incurred when receiving or loading out grain at a maximum rate and would be more representative of the costs at harvest time. Costs would be expected to be higher in periods where less grain is received or a steady flow of grain coming into the elevator is not

TABLE III

WEIGHTED AVERAGE ANNUAL COST PER BUSHEL FOR ELEVATORS
BETWEEN 200,000 AND 399,999 BUSHELS
STORAGE CAPACITY

Cost Item	Received by -- Truck	Loaded out by Truck	Loaded out by Rail	Storage
		Cents		
Fixed Costs				
Depreciation	.691	.222	.462	4.089
Insurance	.133	.043	.089	1.054
Taxes	.128	.041	.085	1.064
Leases & Rentals	--	--	.021	.103
Licenses & Bonds	--	--	--	2.487
Interest	.604	.194	.403	2.832
Total Fixed Cost per bushel	1.556	.500	1.060	11.629
Variable Costs				
Direct Labor	1.955	.629	1.306	11.872
Administrative Overhead	.425	.137	.284	3.949
Electricity & Utilities	.097	.031	.065	.802
Truck	--	.610	--	--
Chemicals	--	--	--	1.337
Repairs	.092	.030	.061	.786
Other Expenses	.071	.023	.047	.140
Total Variable Costs per bushel	2.640	1.460	1.763	18.886
Total Cost per Bushel	4.196	1.960	2.823	30.515

TABLE IV

WEIGHTED AVERAGE ANNUAL COST PER BUSHEL FOR ELEVATORS
BETWEEN 400,000 AND 699,999 BUSHELS
STORAGE CAPACITY

Cost Item	Received by -- Truck	Loaded out by Truck	Loaded out by Rail	Storage
		Cents		
Fixed Costs				
Depreciation	.095	.062	.022	3.984
Insurance	.036	.024	.008	1.509
Taxes	.024	.016	.006	.979
Leases & Rentals	--	--	.364	1.012
Licenses & Bonds	--	--	--	.290
Interest	.043	.028	.010	1.820
Total Fixed Cost per bushel	.198	.130	.410	9.594
Variable Costs				
Direct Labor	2.224	1.445	.515	4.744
Administrative Overhead	.646	.420	.150	2.657
Electricity & Utilities	.095	.061	.022	.408
Truck	--	.493	--	--
Chemicals	--	--	--	.939
Repairs	.252	.164	.058	.891
Other Expenses	.598	.389	.139	1.712
Total Variable Costs per bushel	3.815	2.972	.884	10.851
Total Cost per Bushel	4.013	3.102	1.294	20.445

TABLE V

WEIGHTED AVERAGE ANNUAL COST PER BUSHEL FOR ELEVATORS BETWEEN 700,000 AND 999,999 BUSHELS STORAGE CAPACITY

Cost Item	Received by -- Truck	Loaded out by Truck	Loaded out by Rail	Storage
	Cents			
Fixed Costs				
Depreciation	.182	.106	.065	6.852
Insurance	.056	.032	.020	1.971
Taxes	.022	.013	.008	.907
Leases & Rentals	--	--	.354	--
Licenses & Bonds	--	--	--	.267
Interest	.206	.119	.073	5.992
Total Fixed Cost per bushel	.466	.270	.520	15.988
Variable Costs				
Direct Labor	2.923	1.693	1.041	3.507
Administrative Overhead	.638	.369	.227	.965
Electricity & Utilities	.292	.169	.104	.495
Truck	--	.085	--	--
Chemicals	--	--	--	1.535
Repairs	.250	.145	.089	1.369
Other Expenses	1.364	.790	.486	3.247
Total Variable Costs per bushel	5.467	3.251	1.947	11.118
Total Cost per Bushel	5.933	3.521	2.467	27.107

TABLE VI

WEIGHTED AVERAGE ANNUAL COST PER BUSHEL FOR ELEVATORS
BETWEEN 1,000,000 AND 1,999,999 BUSHELS
STORAGE CAPACITY

Cost Item	Received by -- Truck	Loaded out by Truck	Loaded out by Rail	Storage
		Cents		
Fixed Costs				
Depreciation	.303	.161	.104	4.343
Insurance	.111	.059	.038	1.571
Taxes	.080	.043	.028	1.043
Leases & Rentals	--	--	.125	.040
Licenses & Bonds	--	--	--	.171
Interest	.131	.070	.045	2.362
Total Fixed Cost per bushel	.625	.333	.340	9.530
Variable Costs				
Direct Labor	3.034	1.612	1.040	2.955
Administrative Overhead	.479	.255	.164	2.610
Electricity & Utilities	.125	.066	.043	.980
Truck	--	.138	--	--
Chemicals	--	--	--	.974
Repairs	.456	.242	.156	1.425
Other Expenses	1.698	.902	.582	3.223
Total Variable Costs per bushel	5.792	3.215	1.985	12.167
Total Cost per Bushel	6.417	3.548	2.325	21.697

TABLE VII

WEIGHTED AVERAGE ANNUAL COST PER BUSHEL FOR ELEVATORS WITH 2,000,000 BUSHELS OR MORE STORAGE CAPACITY

Cost Item	Received by -- Truck	Loaded out by Truck	Loaded out by Rail	Storage
	Cents			
Fixed Costs				
Depreciation	1.091	.451	.447	6.087
Insurance	.205	.085	.084	1.188
Taxes	.159	.066	.065	.853
Leases & Rentals	--	--	.056	.040
Licenses & Bonds	--	--	--	.064
Interest	.800	.331	.328	3.119
Total Fixed Cost per bushel	2.255	.933	.980	11.351
Variable Costs				
Direct Labor	1.793	.742	.735	4.127
Administrative Overhead	.449	.186	.184	1.800
Electricity & Overhead	.130	.054	.053	.649
Truck	--	.600	--	--
Chemicals	--	--	--	.535
Repairs	.226	.093	.092	.731
Other Expenses	.341	.141	.140	.654
Total Variable Costs per bushel	2.939	1.816	1.204	8.496
Total Cost per Bushel	5.194	2.749	2.184	19.847

TABLE VIII

WEIGHTED AVERAGE ANNUAL COST PER BUSHEL FOR ALL ELEVATOR STORAGE CAPACITIES

Cost Item	Received by -- Truck	Loaded out by Truck	Loaded out by Rail	Storage
		Cents		
Fixed Costs				
Depreciation	.671	.324	.254	5.511
Insurance	.140	.068	.053	1.354
Taxes	.107	.052	.041	.911
Leases & Rentals	--	--	.145	.189
Licenses & Bonds	--	--	--	.227
Interest	.485	.235	.184	3.056
Total Fixed Cost per bushel	1.403	.679	.677	11.248
Variable Costs				
Direct Labor	2.039	.986	.772	4.314
Administrative Overhead	.505	.244	.191	2.056
Electricity & Utilities	.134	.065	.051	.650
Truck	--	.465	--	--
Chemicals	--	--	--	.777
Repairs	.260	.126	.099	.909
Other Expenses	.677	.327	.256	1.301
Total Variable Costs per bushel	3.615	2.213	1.369	10.007
Total Cost per Bushel	5.018	2.892	2.046	21.255

present.

The average cost for storing grain across all strata is 21.255 cents per bushel. The elevators in the 200,000 to 399,999 bushel and in the 700,000 to 999,999 bushel capacity ranges had storage costs quite a bit higher than the average. An examination of Tables III through VIII provides a means to identify the cost items that are most responsible for the higher costs. Direct labor cost for elevators in the 200,000 to 399,999 range is 11.872 cents per bushel, compared to 4.314 cents per bushel on the average. This may indicate an inefficient use of labor. Elevators in this capacity group may not have the volume in "sideline" operations that other elevators have and thus are not able to utilize labor in other enterprises.

Elevators in the 700,000 to 999,999 bushel range had higher interest and depreciation costs as well as higher repair costs. The higher depreciation costs may result from recent construction of new facilities, where older facilities in other strata may have depreciated out their facilities and thus have lower depreciation costs. The higher interest cost may reflect new investment in elevator facilities as well as a larger proportion of working capital being borrowed versus coming from retained earnings.

The repairs cost is also highest for elevators in the 700,000 to 999,999 bushel range. Repairs may not be conducted on a regular or annual basis and an elevator may go several years without major repairs. Any extensive or larger than normal repair (such as replacing or repairing elevator legs) will be reflected in a higher than average per bushel repair cost.

The trend of storage costs was expected to decrease as the size

of elevators increased. Generally, this can be seen in the results except for those elevators in the 400,000 to 699,999 bushel capacity group. Elevators in this group had lower than average depreciation and interest costs. This could be due to older facilities that have lower depreciation or that are nearly depreciated out. Lower interest costs may indicate that more working capital is coming from retained earnings than from borrowed sources. Elevators in this group also stored an average of 74 percent of their rated capacity compared to 44 to 64 percent in the other groups. Elevators were nearly full following harvest, suggesting that their capacity is being utilized for receiving grain but not for storing grain in excess of 6 months.

Tables IX and X show the handling costs across strata along with the average over all strata. The handling cost, transportation cost, and an interest on working capital cost can be summed and be deducted from the Gulf bid. The interest on working capital is an opportunity cost of employing capital in handling grain, while all other costs are actual out-of-pocket expenses. The interest on working capital was calculated by multiplying the total cost in each function by 12.5 percent interest. This figure is expressed on a per bushel basis and reflects the opportunity cost of 12.5 percent on capital tied up in the elevator department. This does not include risk due to ownership of grain that may occur when transporting or purchasing grain. The maximum price that can be paid for local grain can be obtained in this manner. Risk due to shrinkage and grade loss has not been accounted for and any profit over the opportunity cost is not included in the table. Elevators should also consider these costs when arriving at their margins.

TABLE IX

EFFECTS OF INTEREST AND TRANSPORTATION ON THE AVERAGE TOTAL COST OF HANDLING GRAIN

ELEVATOR CAPACITY (1000 Bushels)	AVERAGE COST (Cents/Bu)	INTEREST[1] ON WORKING CAPITAL (Cents/Bu)	TRANSPORTATION[2] (Cents/Bu)	AVERAGE TOTAL COST (Cents/Bu)
> 2,000	10.127	1.266	55	66.393
1,999 to 1,000	12.290	1.536	55	68.826
999 to 700	11.921	1.490	55	68.411
699 to 400	8.409	1.051	55	64.46
399 to 200	8.979	1.123	55	65.102
OVER POPULATION	9.956	1.278	55	66.234

[1]Interest rate at 12.5 percent.

[2]Transportation is for truck to the Gulf from the Enid, Oklahoma area.

TABLE X

EFFECTS OF INTEREST AND TRANSPORTATION ON THE AVERAGE TOTAL COST OF HANDLING GRAIN

ELEVATOR CAPACITY (1,000 Bushels)	AVERAGE COST (Cents/Bu)	INTEREST[1] ON WORKING CAPITAL (Cents/Bu)	TRANSPORTATION[2] (Cents/Bu)	AVERAGE TOTAL COST (Cents/Bu)
> 2,000	10.127	1.266	60	71.393
1.999 to 1,000	12.290	1.536	60	73.826
999 to 700	11.921	1.490	60	73.411
699 to 400	8.409	1.051	60	69.46
399 to 200	8.979	1.123	60	70.102
OVER POPULATION	9.956	1.278	60	71.234

[1]Interest rate at 12.5 percent.

[2]Transportation is for rail to the Gulf from the Enid, Oklahoma area.

Table XI presents the storage costs for all the strata as well as the average across strata. The interest on working capital represents an opportunity cost for employing capital in the storage function and was calculated at 12.5 percent interest. The costs presented in Tables III through VIII are actual out-of-pocket costs encountered by elevators. By adding the interest on working capital costs, the economic cost of handling and storing grain can be determined.

Statistical Analysis

Standard deviation is the measure of dispersion of individual estimates around a mean. Standard error is the standard deviation of all possible sample means, or an estimate of the dispersion of all possible sample means around the population mean. Standard errors can be used to provide an estimate of the dispersion of the differences between sample means. Standard errors were calculated for storing and handling costs within each stratum and across strata. The following formula was used to calculate the within stratum variance.

$$s_i^2 = \frac{\Sigma (y_i - \bar{y}_i)^2}{n_i - 1}$$

where:

$$\bar{y}_i = \frac{\Sigma (w_i y_i)}{\Sigma w_i}$$

$\bar{y}_i$ = the stratum mean

n_i = stratum sample size

w_i = a weight, in this case, the volume of grain stored or handled was used.

The standard error (standard deviation) of each stratum was obtained by taking the square root of the variance. Confidence limits

TABLE XI

EFFECTS OF INTEREST ON AVERAGE TOTAL COSTS OF STORING GRAIN

ELEVATOR CAPACITY (1,000 Bushels)	AVERAGE COST (Cents/Bu)	INTEREST ON[1] WORKING CAPITAL (Cents/Bu)	AVERAGE TOTAL COST (Cents/Bu)
> 2,000	19.847	2.481	22.328
1,999 to 1,000	21.697	2.712	24.409
999 to 700	27.107	3.389	30.495
699 to 400	20.445	2.556	23.000
399 to 200	30.515	3.814	34.329
OVER POPULATION	21.255	2.657	23.912

[1]Interest rate at 12.5 percent.

were constructed around each stratum mean at the 95 percent confidence level. The confidence limits were obtained from the following formula:

$$\bar{y}_i \pm 2\sqrt{\left(\frac{N_i - n_i}{N_i}\right)\frac{s_i^2}{n_i}}$$

where: N_i = stratum population size

s_i = standard error of the stratum mean.

The variance of the estimate of the population mean was calculated from the following:

$$S_{\bar{Y}}^2 = \frac{1}{N^2} \Sigma N_i^2 \left(\frac{N_i - n_i}{N_i}\right)\frac{s_i^2}{n_i}$$

The standard error of the population mean was obtained by taking the square root of the variance. Confidence limits were constructed around the population mean at the 95 percent level of confidence from the following formula:

$$\bar{Y} \pm 2\sqrt{S_Y^2}$$

The means (weighted average costs), standard errors, and confidence limits are presented in Tables XII and XIII. The confidence intervals indicate that approximately 95 percent of all future observations will lie within this interval.

Handling and storing costs were tested between elevators in the different storage capacity strata. F-tests were conducted on the handling and storing costs to determine if the storage capacity of elevators had a significant effect on handling and storing costs. Table XIV presents the analysis of variance table for testing the equality of handling costs between elevators grouped according to

TABLE XII

ANALYSIS OF VARIANCE AND CONFIDENCE LIMITS ON HANDLING COSTS

ELEVATOR CAPACITY (1000 Bushels)	AVERAGE COST (Cents/Bu)	STANDARD ERROR (Cents/Bu)	CONFIDENCE* LIMIT (Cents/Bu)
> 2,000	10.13	.5152	9.10 to 11.16
1,999 to 1,000	12.29	.9653	10.36 to 14.22
999 to 700	11.92	3.6932	4.53 to 19.31
699 to 400	8.41	.7901	6.83 to 9.99
399 to 200	8.98	4.4176	.14 to 17.82
OVER POPULATION	9.96	1.1485	7.66 to 12.26

*Limits are at the 95 percent level of confidence.

TABLE XIII

ANALYSIS OF VARIANCE AND CONFIDENCE LIMITS
ON STORAGE COSTS

ELEVATOR CAPACITY (1000 Bushels)	AVERAGE COST (Cents/Bu.)	STANDARD ERROR (Cents/Bu.)	CONFIDENCE* LIMIT (Cents/Bu.)
> 2,000	19.85	1.5852	16.68 to 23.02
1,999 to 1,000	21.70	2.5812	16.54 to 26.86
999 to 700	27.11	2.2170	22.68 to 31.54
699 to 400	20.45	1.7335	16.98 to 23.92
399 to 200	30.52	3.4163	23.69 to 37.35
OVER POPULATION	21.26	1.0983	19.06 to 23.46

*Limits are at the 95 percent level of confidence.

storage capacity. The computed F-Value of .65 is less than the tabled F-Value at the 95 percent level. The calculated F-Value is not significant, therefore, the hypothesis that handling costs are not different between strata can be rejected. This implies that the storage capacity of elevators does not significantly effect the cost of handling grain. Table XV presents the analysis of variance table for testing the equality of storage costs between elevators grouped according to storage capacity. The computed F-Value of 3.40 is greater than the tabled F-Value at the 95 percent level. The calculated F-Value is significant and indicates that the cost of storing grain differs between strata. This implies that the storage capacity of elevators significantly effects the cost of storing grain.

The handling and storing costs were also tested between elevators according to the volume of grain handled. Elevators were 'stratified' according to the volume of grain handled by each elevator. The strata were of the same bounds as the previous strata for storage capacities. Tables XVI and XVII present the analysis of variance tables for testing the equality of handling costs, and storage costs between the elevators grouped according to handling volumes. The calculated F-Values in Tables XVI and XVII are not siginificant because they are less than the tabled F-Values, indicating that there is not a significant difference in the handling and storing costs between elevators arranged by handling volumes. This implies that the volume of grain handled does not significantly effect the costs of handling and storing grain.

Handling and storing costs were also tested between elevators according to the volume of grain stored by each elevator. Elevators

TABLE XIV

ANALYSIS OF VARIANCE TABLE FOR TESTING THE EQUALITY OF HANDLING COSTS BETWEEN ELEVATORS GROUPED ACCORDING TO STORAGE CAPACITY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE[1]
Between Strata	4	48.050	12.012	0.65
Within Strata	15	276.463	18.430	
TOTAL	19	324.513		

[1]The corresponding tabled F-Value for the 95% confidence level is 3.06.

TABLE XV

ANALYSIS OF VARIANCE TABLE FOR TESTING THE EQUALITY OF STORAGE COSTS BETWEEN ELEVATORS GROUPED ACCORDING TO STORAGE CAPACITY

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE[1]
Between Strata	4	389.896	97.474	3.40
Within Strata	15	430.533	28.702	
TOTAL	19	820.428		

[1]The corresponding tabled F-Value for the 95% confidence level is 3.06.

TABLE XVI

ANALYSIS OF VARIANCE TABLE FOR TESTING THE EQUALITY OF HANDLING COSTS BETWEEN ELEVATORS GROUPED ACCORDING TO HANDLING VOLUMES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE[1]
Between Groups	2	44.187	22.093	1.34
Within Groups	17	280.326	16.490	
TOTAL	19	324.513		

[1]The corresponding tabled F-Value for the 95% confidence level is 3.59.

TABLE XVII

ANALYSIS OF VARIANCE TABLE FOR TESTING THE EQUALITY OF STORAGE COSTS BETWEEN ELEVATORS GROUPED ACCORDING TO HANDLING VOLUMES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE[1]
Between Groups	2	84.914	42.457	0.98
Within Groups	17	735.514	43.266	
TOTAL	19	820.428		

[1]The corresponding tabled F-Value for the 95% confidence level is 3.59.

were 'stratified' according to the volume of grain stored. The strata were of the same bounds as the previous strata for storage capacities. Table XVIII presents the analysis of variance table for testing the equality of handling costs between elevators grouped according to storage volumes. The calculated F-Value is smaller than the tabled F-Value, indicating that there is not a significant difference in handling costs between elevators grouped by storage volumes. This implies that the volume of grain stored does not effect the cost of handling grain. Table XIX presents the analysis of variance table for testing the equality of storage costs between elevators grouped according to storage volumes. The calculated F-Value is greater than the tabled F-Value, indicating that the costs of storing grain are not equal between elevators grouped according to storage volume. This implies that the volume of grain stored significantly effects the cost of storing grain.

TABLE XVIII

ANALYSIS OF VARIANCE TABLE FOR TESTING THE EQUALITY OF HANDLING COSTS BETWEEN ELEVATORS GROUPED ACCORDING TO STORAGE VOLUMES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE[1]
Between Groups	5	76.195	15.239	0.86
Within Groups	14	248.318	17.737	
TOTAL	19	324.513		

[1]The corresponding tabled F-Value for the 95% confidence level is 2.96.

TABLE XIX

ANALYSIS OF VARIANCE TABLE FOR TESTING THE EQUALITY OF STORAGE COSTS BETWEEN ELEVATORS GROUPED ACCORDING TO STORAGE VOLUMES

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F-VALUE[1]
Between Groups	5	445.146	89.029	3.32
Within Groups	14	375.282	26.806	
TOTAL	19	820.428		

[1]The corresponding tabled F-Value for the 95% confidence level is 2.96.

CHAPTER V

SUMMARY AND CONCLUSIONS

The results and procedures developed in this study can be a useful tool for grain elevator managers. These procedures can be used to determine the changes in costs associated with storing and handling grain. The fixed costs will remain relatively stable from year to year but the variable costs will fluctuate as grain elevators adjust to current market conditions. The cost breakdowns indicate the relative importance of individual expense items in storing and handling grain. The ability to detect changes in costs and properly adjust to these changes will become more important as competition for available grain supplies becomes more intense. Elevators can utilize the procedures developed in this study to determine their costs of storing and handling grain from year to year. The average costs for the industry are important and serve as a guideline for comparison. Individual elevators can compare their costs with the industry average to see how they stand or how their costs have changed relative to the industry.

Many of the cost items are difficult to separate from the whole operation and allocate to storing or handling functions. Labor and depreciation costs are two of the more significant costs and are subject to variation between elevators. Labor costs ranged from 32 to 50 percent of the cost of handling grain and from 13 to 40 percent of

the annual cost of storing grain. Depreciation costs ranged from 2 to 20 percent of the cost of handling grain and from 13 to 30 percent of the annual cost of storing grain.

The labor costs per bushel depend on the efficiency of each elevator. Labor costs were determined from the time spent in the storing and handling activities and the rates of receiving and loading out grain. The rates used in this study were the maximum rates of handling grain for each elevator. These rates depend on the type of equipment, capacity of equipment and the efficiency of their operation. For example, when loading out grain by rail car, the facility may have the capacity to load out 10,000 bushels per hour, but may only actually load out 7,000 bushels per hour because rail cars may have to be moved or positioned. The Bu/Hr capacities of receiving and loading out grain in this study may overstate the actual capacities encountered under normal operating conditions, resulting in lower per bushel costs. Down time or idle time of labor will increase the per bushel cost of handling grain. Elevators with other 'sideline' enterprises may be at an advantage because labor can be utilized in the other departments when the elevator department is idle, thus reducing the cost per bushel.

The depreciation costs vary between elevators, depending on the age and type of facility. Older facilities may have already depreciated much of their facility, while elevators that have recently invested in new storage or handling facilities will have a larger depreciation cost. A more uniform depreciation cost can be obtained by standardizing depreciation rates. Schienbein applied standardized rates to the elevator acquisition values and thus eliminated the

effects of this type of variation on depreciation costs.

Administrative overhead, Interest and the Other Expenses also vary among elevators. Administrative overhead will fluctuate because of the different management practices in each elevator. Elevators with a higher administrative overhead cost may have a more intensive management structure or a more diversified operation that requires more administrative personnel. Interest costs seem to increase as depreciation costs increase, and decrease as depreciation costs decrease. Interest and depreciation may be directly related to the age of elevator facilities. High interest and depreciation costs may reflect recent investment in storage and handling facilities. The higher per bushel costs of constructing and financing new facilities will increase the costs of storing and handling grain relative to older or existing facilties. The costs listed as Other Expenses are similiar in nature to Repairs. Elevators may go several years without any major repairs and then make extensive repairs to elevator equipment or facilities in a short period of time. This can increase the costs of storing and handling grain in those years when repairs are made. Other Expenses are similiar in nature and serve as a 'catch all' or miscellaneous expense item for expenses not specifically listed. Some of the expenses that may be included in this category may not occur on a regular basis, causing higher per bushel costs in the years of higher expenses.

The storing and handling costs, that were computed using expense information from the mail surveys, may not be completely comparable. The following factors should be considered when comparing the costs between elevators.

1. Different storage capacities
2. Volume of grain stored and handled
3. Number and size of 'sideline' operations
4. Regional differences in operating costs
5. Management.

This study took the first two factors into consideration when analyzing the costs of storing and handling grain. Differences in costs that may be due to the last three factors have not been addressed in this study.

The costs of storing and handling grain were expected to be strongly influenced by the volumes stored and handled. The storage function of the elevator cannot operate without the handling function, and vice versa. Grain is received, stored for a period of time, and then shipped out. The tests in Chapter IV indicate that storage capacities and storage volumes influence storage costs, but handling volumes do not significantly effect the handling costs. This can be misleading, because the volumes of grain stored and handled may be significant factors in determining the costs, but there are other factors that have an effect on the costs also. The three factors listed previously, that were not addressed in this study, can have a significant impact on the cost structure of an individual elevator. Any increase or decrease in costs due to changing volumes could be offset by one of those factors,....primarily management. The test to see if handling costs differed between elevators grouped according to volume of grain handled indicated that there was not a significant difference in costs. The larger capacity elevators were expected to have lower per unit costs, due to larger, more efficient equipment and

facilities, more efficient use of labor, and larger volumes of grain handled. A closer look at the larger capacity elevators revealed that the larger storage capacities and handling volumes were achieved from the combined operation of several, smaller capacity branch elevators (ranging in capacity from 120,000 to 600,000 bu.). Operating an elevator composed of several, less efficient branch elevators, offsets the expected efficiency from handling larger volumes of grain in a single, large capacity elevator. This can help explain why there is not a significant difference in handling costs between elevators grouped according to handling volumes.

Elevators sell grain according to official grades and standards, but very little grain is actually purchased by these standards from farmers. Each elevator has its own system of dockage, usually based on weight and moisture content. Losses due to excess shrinkage and other quality deterioration are not included in this study. The amount of the loss depends on the condition of the grain and current market prices. Customers who store their grain at the elevator are transferring their risk to the elevator and the elevator must take this risk into consideration when developing dockage and pricing strategies.

Areas For Future Research

A trend of weighted average costs of storing and handling grain could be obtained by conducting this study on a yearly basis. The survey questionnaire could be streamlined to facilitate its use and ease the burden of completing it. Comparisons of costs between elevators are useful, but comparisons between years would be even more

beneficial in examining the effects of different volumes of grain stored and handled. The effects of some of the variable costs, that are incurred on an irregular basis can be 'smoothed out' by averaging the costs over several years.

Future studies of storing and handling costs can use personal interviews to obtain information regarding 'sideline' operations and management practices. Information of this nature is difficult to obtain from a mail survey, but would provide more accurate information for determining differences in elevator costs.

SELECTED BIBLIOGRAPHY

Briscoe, Nellis A., Allen J. Baker, and Edward M. Corley. Cost Characteristics and Management Decisions of Oklahoma Co-op Grain Elevators. O.S.U. Experiment Station, Processed Series P-545, August 1966.

Brown, Charles W. "Cost Characteristics and Management Decisions of Oklahoma Cooperative Grain Elevators." Unpub. Ph.D. Dissertation, Oklahoma State University, 1963.

Corley, Edward M., and Nellis A. Briscoe. Effects of Wheat Production Variations on Country Elevator Handling Costs in Northwestern Oklahoma. Oklahoma State University Experiment Station, Processed Series P-516, September 1965.

Davis, Christopher Don. "The Costs and Returns Associated With On-Farm Storage of Wheat in Oklahoma". Unpub. M.S. thesis, Oklahoma State University, 1980.

Driscoll, J. L. "An Analysis of Expected Returns to Oklahoma Grain Elevators from Alternative Hedged Wheat Storage Practices." Unpub. Ph.D. dissertation, Oklahoma State University, 1969.

Elsener, Monty Joe. "Development of a Financial Simulation Model for Grain Elevator Firms." Unpub. M.S. thesis, Oklahoma State University, 1977.

Geis, Alvin Charles. "Gross Margins and Expense Allocation of Selected Oklahoma Cooperative Business Firms." Unpub. M.S. thesis, Oklahoma State University, 1965.

Ghetti, Joseph L., Allen G. Schienbein, and Rodney C. Kite. Costs of Storing and Handling Grain in Commercial Elevators, 1967-68 and Projections for 1969-70. Washington, D.C.: USDA, ERS-401, Feb. 1969.

Hall, T. E. New Country Elevators--Influence of Size and Volume on Operating Costs. Washington, D.C.: USDA, Farmer Cooperative Service Circular 10, 1955.

Matz, Adolf and Milton F. Usry. Cost Accounting Planning and Control, 6th edition. Cincinnati: Southwestern Publishing Co., 1976.

Moulton, Kirby S., and R. H. Courtney. Costs and Profitability of Feed Grain Storage in the San Joaquin Valley, California. Giannini Foundation of Agricultural Economics No. 72-2, University of California, Berkeley, Dec. 1972.

Oehrtman, Robert L. Costs of Receiving, and Loading Grain by Truck, Rail and Water, and the Costs of Storing Grain at Country Elevators for Fiscal Years 1964-65 to 1977-78. Rail Wheat Efficiency Study, Technical Memorandum AE-7717, Oklahoma State University, Sept. 1977.

Page, R.E., P. D. Hummer, and B. D. Romine. Financial Anaylsis of Grain and Supply Cooperatives in Oklahoma. Oklahoma State University Extension, Circular E-813, Oklahoma State University, 1978.

Sampford, M. R. An Introduction to Sampling Theory. London: Oliver and Boyd, 1962.

Schienbein, Allen G. Costs of Storing and Handling Grain in Commercial Elevators, 1970-71 and Projections for 1972-73. Washington, D.C.: USDA, ERS-501, March 1972.

Schienbein, Allen G. and Carl J. Vosloh, Jr. Cost of Storing and Handling Grain and Controlling Dust in Commercial Elevators, 1971-72...Projections for 1973-74. Washington, D.C.: USDA ERS-513, March 1973.

Schienbein, Allen G. "Cost of Storing and Handling Grain in Commercial Elevators. Projections for 1974-75." Feed Situation, 252, Feb. 1974, pp. 31-42.

Schienbein, Allen G. Estimated Cost of Storing and Handling Grain in Commercial Elevators, 1971-72. Washington, D.C.: USDA ERS-475, March 1971.

Schnake, L. D. Grain Dust: Problems and Utilization. Washington, D.C.: USDA, ERS, April 1981.

Sloan, Roby Lee. "Relationship of Cost Characteristics of a Cooperative Association to Contracting Volumes of Grain Handled." Unpub. M.S. thesis, Oklahoma State University, 1960.

Snedecor, George W., and William G. Cochran. Statistical Methods. Ames: The Iowa State University Press, 1980.

Thurston, Stanley K., and R. J. Mutti. Cost-Volume Relationships for New Country Elevators in the Corn Belt. Washington, D. C.: USDA, Farmer Co-operative Service, Service Report 32, 1957.

U.S. Department of Agriculture. Costs of Storing and Handling Grain in Commercial Elevators, 1964-65. Washington, D.C.: ERS-288, April 1966.

Yager, Francis P. Country Elevators - Cost-Volume Relations in the Spring Wheat Belt. Washington, D.C.: USDA, Farmer Cooperative Service, Service Report 63, 1963.

Yates, Frank. Sampling Methods for Censuses and Surveys 4th Edition. New York: Macmillan Co., 1981.

APPENDIX A

COUNTRY GRAIN ELEVATOR SURVEY

OKLAHOMA STATE UNIVERSITY
Department of Agricultural Economics
Stillwater, Oklahoma 74078
December 21, 1982

COUNTRY GRAIN ELEVATOR SURVEY

1. What was the total volume of grain stored and handled in your system's facilities in fiscal 1980? Consider all elevators as one unit. (Inventory at end of month equals warehouse receipts + open storage + company owned grain.)

Month	Inventory at End of Month (Bushels)

_____ Total bushels transferred between branches.

_____ Total bushels handled.

2.a.)In 1980, how many bushels did you receive by

Truck? _____bu.

Rail? _____bu.

b.)In 1980, how many bushels did you load out by

Truck? _____bu.

Rail? _____bu.

Water? _____bu.

3.a.)What is the total receiving capacity for handling grain in your system by:

Truck? _____bu/hr.

Rail? _____bu/hr.

b.)What is the total loading out capacity for handling grain in your system by:

Truck? _____bu/hr.

Rail? _____bu/hr.

Water? _____bu/hr.

4. During an average year, how many times do you turn your stored grain for blending and conditioning purposes?

_____times per year.

_____bu. Average number of bushels turned.

_____bu/hr. Average rate of turning grain for your system.

5. How many bushels of grain did you merchandise in 1980 that did not pass through your facilities or were not handled directly by your equipment? _____ bu.

6. Please list the 1980 storage capacity of each branch or satellite station that is included in this data.

_____bu.

_____bu.

_____bu.

_____bu.

7. On an annual basis, what percentage of the elevator's total storage capacity was designated for the following functions in 1980?

_____% handling (receiving and loading out only)

_____% storage (including turning)

Other(please specify)

_____% _____

_____% _____

100 % Total

8. What percentage of the operating expenses for all "other" buildings may be applied to the operation of the grain handling and storage functions(shops, warehouses, etc.)

_____% handling (receiving and loading out only)

_____% storage (includes turning)

9. Number of full time (year around) employees._____

Man Hours	Percentage	(fill out one of the columns)
_____	_____%	full time employees time spent working in grain handling related activities.
_____	_____%	full time employees time spent working in grain storage related activities.(includes turning)
_____	_____%	full time employees time spent working in all other activities.

100 % Total.

10. Number of part-time (6 months or less) employees._____

_____ Average number of weeks worked.

Man Hours	Percentage	(fill out one of the columns)
_____	_____%	part-time employees time spent working in grain handling related activities.
_____	_____%	part-time employees time spent working in grain storage related activities.(includes turning)
_____	_____%	part-time employees time spent working in all other activities.

100 % Total

11. What amount of the total labor expense (salaries and wages) can be attributed to part-time employees? $_____

12. What are the total annual hours that all facilities in the system operated during 1980?

_____hours

13a.)What percentage of your Administrative (office management and staff) Overhead would be allocated to:

a-1 _____% elevator

a-2 _____% other

a-3 100 % Total

b.)Of the Administrative Overhead allocated to the elevator in 13-a-1 above, how much may be applied to:

_____% handling

_____% storage

100 % Total

14a.)What dollar amount of your total Leases and Rentals (equipment, buildings, and land) can be attributed strictly to the elevator in 1980? $_____

b.)Of these Leases and Rentals devoted to the elevator, how much was utilized in:

_____% handling (receiving and loading out only)

_____% storage (includes turning)

100 % Total

15a.)What percentage of your total electricity and utilities in 1980 was devoted to the elevator function?_____%

b.)Of the total value of electricity and utilities devoted to the elevator, how much was utilized by:

_____% handling (receiving and loading out only)

_____% storage (includes turning)

100 % Total

16a.)What percentage of your working capital was used in the elevator function in 1980? _____% elevator

b.)Of the working capital devoted to the elevator, how much was utilized by:

_____% handling (receiving and loading out only)

_____% storage (includes turning)

100 % Total

c.)What was the major source of your short-term or working capital in 1980? (Bank for Cooperatives, Commercial Banks, Retained earnings, _____other.)(Circle One)

d.)What was the average annual interest rate charged for this capital during 1980?_____%

17a.)Have you recently purchased storage or handling facilities that are now in service?

_____Yes _____No

b.)If yes, please indicate:

_____ bu.

_____ amount of investment

_____ type of facilities

_____ date of investment

18a.)Are you considering adding any storage capacity in the future?
_____Yes _____No

b.)If yes, how much increase in storage capacity are you considering adding? _____bu.

19a.)Are you considering converting currently owned storage facilities from other uses (such as fertilizer storage) for use in grain storage? _____Yes _____No.

_____bu. capacity

_____type of facility
(flat, upright, concrete, etc.)

The following information asked for is rather specific in nature and is the only additional data needed to complete this survey. This information should be obtainable from your detailed income statement or audit records for 1980. At this point, we would be willing to take the time to gather this information directly from your accountant or auditor, if you prefer. Only the information indicated on the form would be obtained and would be held in strictest confidence. If you prefer us to obtain this data, please list your accountant or auditor's name, address, and phone number below and simply return the completed portion of the survey. If you choose to fill out the last page, please note that the expense schedule asks for a breakdown of Depreciation into several categories. The acquisition costs of the elevator facilities and total business operation are also needed as these figures are important in several portions of the study and accuracy depends greatly on the breakdowns between these items. When you have completed the survey, please return it in the enclosed self-addressed envelope.

Thank you.

Name _____ Accountants Name_____

Address_____ Address_____

_____ _____

Phone No. _____ Phone No._____

_____
Signature

EXPENSE INFORMATION FOR 1980

(Those items with asterisks include only expenses for the elevator. Expenses for all other items are for the entire operation.)

Depreciation: Elevator facilities(bins & equip.)_____

Office Building _____

Other Buildings (shop,warehouse,etc.) _____

Total Depreciation _____

Insurance and Bonds _____

Taxes _____

Licenses and Inspections(including scales and warehouse) _____

Administrative Overhead (Gross salary and fringe benefit expenses for office mgt. & staff) _____

All other employees (Gross salary, wages and fringe benefit expenses) _____

Total Gross Salaries and Wage expense for all personnel (includes payroll taxes, retirement benefits, medical insurance and bonuses.) _____

Electricity and Utilities _____

Interest Expense _____

Fumigation & Chemicals _____

* Truck Expense (Grain Elevator) _____

* Repairs on elevator _____

* All Other Expenses related only to the grain elevator _____

Total Overall Expenses _____

Total Original Acquisition Cost of Elevator(bins & equip.) _____

Total Asset Acquisition Value_____

Working Capital(current assets minus current liabilities) _____

Percentage of Total Expenses incurred by the grain elevator _____%

APPENDIX B

VISICALC TEMPLATES

MASTER/VC FOR SURVEYS

ROWS	1	NAME OR YEAR	ROWS	36	% TIME HANDLING .
	2	JANUARY		37	% TIME STORING. .
	3	FEBRUARY.		38	# OF PARTTIMERS .
	4	MARCH		39	WEEKS WORKED. . .
	5	APRIL		40	% TIME HANDLING .
	6	MAY		41	% TIME STORING. .
	7	JUNE.		42	% ADMIN ELEVATOR.
	8	JULY.		43	% TO HANDLING . .
	9	AUGUST.		44	% TO STORING. . .
	10	SEPTEMBER		45	ELEV. LEASES. . .
	11	OCTOBER		46	% TO HANDLING . .
	12	NOVEMBER.		47	% TO STORING. . .
	13	DECEMBER.		48	% UTILITIES ELEV.
	14	AVG.BU. STORED. .		49	% TO HANDLING . .
	15	BU. HANDLED . . .		50	% TO STORING. . .
	16	TRUCK IN.		51	% WORK.CAP. ELEV.
	17	RAIL IN		52	% TO HANDLING . .
	18	TRUCK OUT		53	% TO STORING. . .
	19	RAIL OUT.		54	% INT.ON WORK.CAP
	20	WATER OUT		55	ELEVATOR DEP. . .
	21	BU/HR TRUCK IN. .		56	OFFICE DEP. . . .
	22	BU/HR RAIL IN . .		57	OTHER DEP . . . .
	23	BU/HR TRUCK OUT .		58	TOTAL DEP . . . .
	24	BU/HR RAIL OUT. .		59	INSURANCE . . . .
	25	BU/HR WATER OUT .		60	TAXES . . . . .
	26	TIMES TURNED/YR .		61	LICENSES. . . . .
	27	BU TURNED		62	ADMIN. OVERHEAD .
	28	BU/HR TURNING . .		63	OTHER WAGES . . .
	29	NOT HANDLED . . .		64	UTILITIES . . . .
	30	TOTAL CAPACITY. .		65	INTEREST. . . . .
	31	% FOR HANDLING. .		66	CHEMICALS . . . .
	32	% FOR STORAGE . .		67	TRUCKS. . . . .
	33	% OTHER FOR HAN .		68	REPAIRS . . . . .
	34	% OTHER FOR STO .		69	OTHER ELEV.EXPEN.
	35	# OF FULLTIMERS .		70	WORK. CAPITAL . .

ROWS				
	83	FIXED EXPENSES	----------	
	84	STORAGE	DEPRECIATION	4.51
	85			
	86		INSURANCE	0.85
	87			
	88		TAXES	0.61
	89			
	90		LEASES	0.18
	91			
	92		LICENSES	0.01
	93			
	94		INTEREST	1.81
	95		----------	
	96		TOTAL	7.97
	97			
	98	----------		
	99			
	100	FIXED EXPENSES	----------	
	101	HANDLING	TOT DEPRECIATION	1.45
	102		TRUCK IN	0.78
	103		TRUCKOUT	0.48
	104		RAIL OUT	0.18
	105			
	106		TOT INSURANCE	0.27
	107		TRUCK IN	0.15
	108		TRUCKOUT	0.09
	109		RAIL OUT	0.03
	110			
	111		TOT TAXES	0.19
	112		TRUCK IN	0.11
	113		TRUCKOUT	0.06
	114		RAIL OUT	0.02
	115			
	116		LEASES--RAIL OUT	0.03
	117			
	118		INTEREST	0.58
	119		TRUCK IN	0.31
	120		TRUCKOUT	0.19
	121		RAIL OUT	0.07
	122			
	123	----------		

ROWS	125	VARIABLE EXPENSES----------		
	126	STORAGE	DIRECT LABOR	2.78
	127			
	128		ADMIN. OVERHEAD	1.85
	129			
	130		UTILITIES	0.61
	131			
	132		CHEMICALS	0.86
	133			
	134		REPAIRS	0.89
	135			
	136		OTHER EXPENSES	1.21
	137		----------	
	138		TOTAL	8.19
	139			
	140	----------		
	141			
	142	VARIABLE EXPENSES----------		
	143	HANDLING	DIRECT LABOR	1.69
	144		TRUCK IN	0.91
	145		TRUCKOUT	0.56
	146		RAIL OUT	0.21
	147			
	148		ADMIN. OVERHEAD	1.83
	149		TRUCK IN	0.99
	150		TRUCKOUT	0.61
	151		RAIL OUT	0.23
	152			
	153		UTILITIES	0.13
	154		TRUCK IN	0.07
	155		TRUCKOUT	0.04
	156		RAIL OUT	0.02
	157			
	158		TRUCK---TRUCK OUT	0.87
	159			
	160		REPAIRS	0.22
	161		TRUCK IN	0.12
	162		TRUCKOUT	0.07
	163		RAIL OUT	0.03
	164			
	165		OTHER EXPENSES	0.10
	166		TRUCK IN	0.05
	167		TRUCKOUT	0.03
	168		RAIL OUT	0.01
	169			
	170	----------		

```
ROWS 171   TOT FIXED EXPENSE
     172                    STORAGE                          7.97
     173
     174                    HANDLING                         2.52
     175   ------------------------------------------------------
     176   TOT VAR. EXPENSES
     177                    STORAGE                          8.19
     178
     179                    HANDLING                         4.84
     180   ------------------------------------------------------
     181    TOTAL EXPENSES
     182                    STORAGE                         16.16
     183
     184                    HANDLING                         7.36
     185   ------------------------------------------------------
     186     DATA FOR THE AVERAGE/VC
     187       VISICALC PROGRAM
     188      (SAVE IN DIF FILE)
     189      (C186 - ?214)
```

```
>C214:(C143)
>C213:(C165)
>C212:(C160)
>C211:(C158)
>C210:(C153)
>C209:(C148)
>C208:(C126)
>C207:(C136)
>C206:(C134)
>C205:(C132)
>C204:(C130)
>C203:(C128)
>C202:(C118)
>C201:(C116)
>C200:(C111)
>C199:(C106)
>C198:(C101)
>C197:(C94)
>C196:(C92)
>C195:(C90)
>C194:(C88)
>C193:(C86)
>C192:(C84)
>C191:(C19)
>C190:(C18)
>C189:(C16)
>C188:(C15)
>C187:(C14)
>C186:@SUM(C16...C19)
>C184:(C174+C179)
>C182:(C172+C177)
>C179:(C148+C153+C158+C160+C165+C143)
>C177:(C138)
>C174:(C101+C106+C111+C116+C118)
>C172:(C96)
>C168:(C165)*(C19/C76)
>C167:(C165)*(C18/C76)
>C166:(C165)*(C16/C76)
>C165:((C15-C29)/(C14+(C15-C29))*C69)/C74
>C163:(C160)*(C19/C76)
>C162:(C160)*(C18/C76)
>C161:(C160)*(C16/C76)
>C160:((C78/(C77+C78))*C68)/C74
>C158:(C67/C74)
>C156:(C153)*(C19/C76)
>C155:(C153)*(C18/C76)
>C154:(C153)*(C16/C76)
>C153:(C48*C49*C64)/C74
>C151:(C148)*(C19/C76)
>C150:(C148)*(C18/C76)
>C149:(C148)*(C16/C76)
>C148:(C42*C43*C62)/C74
>C146:(C143)*(C19/C76)
>C145:(C143)*(C18/C76)
```

```
>C144:(C143)*(C16/C76)
>C143:(((C80*C78)/((C77+C78)*(C79+C80)))*C63)/C74
>C138:(C128+C130+C132+C134+C136+C126)
>C136:((C14/(C14+(C15-C29)))*C69)/C73
>C134:((C77/(C77+C78))*C68)/C73
>C132:(C66/C73)
>C130:(C48*C50*C64)/C73
>C128:(C42*C44*C62)/C73
>C126:(((C79*C77)/((C77+C78)*(C79+C80)))*C63)/C73
>C121:(C118)*(C19/C76)
>C120:(C118)*(C18/C76)
>C119:(C118)*(C16/C76)
>C118:(C75*C65)/C74
>C116:(C46*C45)/C74
>C114:(C111)*(C19/C76)
>C113:(C111)*(C18/C76)
>C112:(C111)*(C16/C76)
>C111:(C75*C60)/C74
>C109:(C106)*(C19/C76)
>C108:(C106)*(C18/C76)
>C107:(C106)*(C16/C76)
>C106:(C75*C59)/C74
>C104:(C101)*(C19/C76)
>C103:(C101)*(C18/C76)
>C102:(C101)*(C16/C76)
>C101:((C31*C55)+(C42*C43*C56)+(C33*C57))/C74
>C96:(C84+C86+C88+C90+C92+C94)
>C94:(C81*C65)/C73
>C92:(C61/C73)
>C90:(C47*C45)/C73
>C88:(C81*C60)/C73
>C86:(C81*C59)/C73
>C84:((C32*C55)+(C42*C44*C56)+(C34*C57))/C73
>C81:(C32*(C55/C58))+(C42*C44*(C56/C58))+(C34*(C57/C58))
>C80:(C35*C36)+(C38*C41*(C39/52))
>C79:(C35*C37)+(C38*C41*(C39/52))
>C78:(C16/C21)+(C18/C23)+(C19/C24)
>C77:(C26)*(C27/C28)
>C76:(C16+C17+C18+C19+C20)
>C75:(C31*(C55/C58))+(C42*C43*(C56/C58))+(C33*(C57/C58))
>C74:(C15/100)
>C73:@AVERAGE(C2...C13)/100
>C14:@AVERAGE(C2...C13)
/W1
/GOC
/GRM
/GF$
/GC17
```

AVERAGE/VC FOR AVERAGE WEIGHTED COSTS

ROWS			
69	FIXED EXPENSES	----------	
70	STORAGE	DEPRECIATION	6.09
71			
72		INSURANCE	1.19
73			
74		TAXES	0.85
75			
76		LEASES	0.04
77			
78		LICENSES	0.06
79			
80		INTEREST	3.12
81		----------	
82		TOTAL	11.35
83			
84	----------		
85			
86	FIXED EXPENSES	----------	
87	HANDLING	TOT DEPRECIATION	1.99
88		TRUCK IN	1.09
89		TRUCKOUT	0.45
90		RAIL OUT	0.45
91			
92		TOT INSURANCE	0.37
93		TRUCK IN	0.20
94		TRUCKOUT	0.08
95		RAIL OUT	0.08
96			
97		TOT TAXES	0.29
98		TRUCK IN	0.16
99		TRUCKOUT	0.07
100		RAIL OUT	0.07
101			
102		LEASES--RAIL OUT	0.05
103			
104		INTEREST	1.46
105		TRUCK IN	0.80
106		TRUCKOUT	0.33
107		RAIL OUT	0.33
108			
109	----------		

ROWS				
	111	VARIABLE EXPENSES	----------	
	112	STORAGE	DIRECT LABOR	4.13
	113			
	114		ADMIN. OVERHEAD	1.80
	115			
	116		UTILITIES	0.65
	117			
	118		CHEMICALS	0.53
	119			
	120		REPAIRS	0.73
	121			
	122		OTHER EXPENSES	0.65
	123		----------	
	124		TOTAL	5.93
	125			
	126	----------		
	127			
	128	VARIABLE EXPENSES	----------	
	129	HANDLING	DIRECT LABOR	3.27
	130		TRUCK IN	1.79
	131		TRUCKOUT	0.74
	132		RAIL OUT	0.73
	133			
	134		ADMIN. OVERHEAD	0.82
	135		TRUCK IN	0.45
	136		TRUCKOUT	0.19
	137		RAIL OUT	0.18
	138			
	139		UTILITIES	0.24
	140		TRUCK IN	0.13
	141		TRUCKOUT	0.05
	142		RAIL OUT	0.05
	143			
	144		TRUCK---TRUCK OUT	0.60
	145			
	146		REPAIRS	0.41
	147		TRUCK IN	0.23
	148		TRUCKOUT	0.09
	149		RAIL OUT	0.09
	150			
	151		OTHER EXPENSES	0.62
	152		TRUCK IN	0.34
	153		TRUCKOUT	0.14
	154		RAIL OUT	0.14
	155			
	156	----------		

ROWS 157	TOT FIXED EXPENSE		
158		STORAGE	11.35
159			
160		HANDLING	4.17
161	---	---	---
162	TOT VAR. EXPENSE		
163		STORAGE	5.93
164			
165		HANDLING	5.96
166	---	---	---
167	TOTAL EXPENSES		
168		STORAGE	17.28
169			
170		HANDLING	10.13
171	---	---	---
172	INTEREST/W.C. @		
173	.125	STORAGE	2.16
174			
175		HANDLING	1.27
176	---	---	---

```
>C175:(C170*A173)
>C173:(C168*A173)
>C170:(C160+C165)
>C168:(C158+C163)
>C165:(C134+C139+C144+C146+C151+C129)
>C163:(C124)
>C160:(C87+C92+C97+C102+C104)
>C158:(C82)
>C154:(C151*E38)
>C153:(C151*D38)
>C152:(C151*C38)
>C151:@SUM(C61...AM61)/C33
>C149:(C146*E38)
>C148:(C146*D38)
>C147:(C146*C38)
>C146:@SUM(C60...AM60)/C33
>C144:@SUM(C59...AM59)/C33
>C142:(C139*E38)
>C141:(C139*D38)
>C140:(C139*C38)
>C139:@SUM(C58...AM58)/C33
>C137:(C134*E38)
>C136:(C134*D38)
>C135:(C134*C38)
>C134:@SUM(C57...AM57)/C33
>C132:(C129*E38)
>C131:(C129*D38)
>C130:(C129*C38)
>C129:@SUM(C63...AM63)/C33
>C124:@SUM(C114...C112)
>C122:@SUM(C54...AM54)/C32
>C120:@SUM(C53...AM53)/C32
>C118:@SUM(C52...AM52)/C32
>C116:@SUM(C51...AM51)/C32
>C114:@SUM(C50...AM50)/C32
>C112:@SUM(C56...AM56/C32
>C107:(C104*E38)
>C106:(C104*D38)
>C105:(C104*C38)
>C104:@SUM(C49...AM49)/C33
>C102:@SUM(C48...AM48)/C33
>C100:(C97*E38)
>C99:(C97*D38)
>C98:(C97*C38)
>C97:@SUM(C47...AM47)/C33
>C95:(C92*E38)
>C94:(C92*D38)
>C93:(C92*C38)
>C92:@SUM(C46...AM46)/C33
```

```
>C90:(C87*E38)
>C89:(C87*D38)
>C88:(C87*C38)
>C87:@SUM(C45...AM45)/C33
>C82:(C70+C72+C74+C76+C78+C80)
>C80:@SUM(C44...AM44)/C32
>C78:@SUM(C43...AM43)/C32
>C76:@SUM(C42...AM42)/C32
>C74:@SUM(C41...AM41)/C32
>C72:@SUM(C40...AM40)/C32
>C70:@SUM(C39...AM39)/C32
>C63:(C31*C3)
>C62:(C30*C3)
>C61:(C29*C3)
>C60:(C28*C3)
>C59:(C27*C3)
>C58:(C26*C3)
>C57:(C25*C3)
>C56:(C24*C2)
>C55:(C23*C2)
>C54:(C22*C2)
>C53:(C21*C2)
>C52:(C20*C2)
>C51:(C19*C2)
>C50:(C18*C2)
>C49:(C17*C3)
>C48:(C16*C3)
>C47:(C15*C3)
>C46:(C14*C3)
>C45:(C13*C3)
>C44:(C12*C2)
>C43:(C11*C2)
>C42:(C10*C2)
>C41:(C9*C2)
>C40:(C8*C2)
>C39:(C7*C2)
>C38:(C34/C37)
>C37:@SUM(C1...AM1)
>C36:@SUM(C6...AM6)
>C35:@SUM(C5...AM5)
>C34:@SUM(C4...AM4)
>C33:@SUM(C3...AM3)/100
>C32:@SUM(C2...AM2)/100
/W1
/GOR
/GRM
/GF$
/GC18
/X>A1:>A1:
```

VITA

Jeff R. Marshall

Candidate for the Degree of

Master of Science

Thesis: COSTS OF STORING AND HANDLING GRAIN IN OKLAHOMA COOPERATIVE ELEVATORS

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Yerington, Nevada, May 31, 1956, the son of Mr. and Mrs. Emory L. Marshall.

Education: Graduated from Douglas County High School, Minden, Nevada in May, 1974; received Bachelor of Science degree in Agriculture from the University of Nevada, Reno, in May, 1979; completed requirements for the Master of Science degree at Oklahoma State University in July, 1983.

Professional Experience: Graduate Research and Teaching Assistant, Department of Agricultural Economics, August 1981 to July 1983.